AMERICAN SOCIETY OF CIVIL ENGINEERS.

INSTITUTED 1852.

TRANSACTIONS.

NOTE.—This Society is not responsible, as a body, for the facts and opinions advanced in any of its publications.

CCLXXXI.

(Vol. XIII.—June, 1884.)

ADDRESS

AT THE ANNUAL CONVENTION, AT BUFFALO, N. Y., JUNE 10TH, 1884,

BY

D. J. WHITTEMORE, President Am. Soc. C. E.

Members of the American Society of Civil Engineers:

GENTLEMEN: The high object of our profession is to consider and determine the most economic use of time, power and matter. In this we are gravely responsible, not merely to ourselves, nor yet alone to this Society, but to that large, restless and progressive portion of the civilized world which our organization assumes to represent. Upon the results of your industry and study largely depend the fortunes of a great people and the future of a continent yet in the infancy of its physical resources and material power. I am confident that a consciousness of these relations of our profession to human progress will never fail to prove a controlling incentive to duty and fidelity in your relations to this Society, and in every field of labor to which you may be called.

It gives me special pleasure to assure you of the present prosperity of our Society, and of its rapid progress in all the necessary conditions

of permanent usefulness and strength. The number of persons now connected with the organization, in all relations, is 837, of whom no less than 622 belong to the grade of members of the first class. It has been, and I trust it will continue to be, the policy of the Society to accept for membership of any class only such as are properly entitled thereto under the wise provisions of our by-laws.

Without attempting to give in this address a detailed statement of the engineering progress of the past year, I briefly call your attention to the works of our Canadian brethren, in deepening the channels of their rivers; in building their railway across the continent, and in the discovery by a member of this Society of the Rogers Pass through the Selkirk Range (happily bearing the name of the discoverer), thereby assuring the early completion of the magnificent enterprise of connecting the two oceans by rail on provincial territory. I also congratulate you upon the rapid progress of railway construction in Mexico, increasing in the last few years from a mileage of three hundred to three thousand miles of completed lines at the present time.

Among the important subjects now legitimately under consideration by our Society is that of reckoning and denoting time. It is not surprising that members of our profession should have been the first to suggest practicable reforms in this direction; and it is a gratifying fact in the history of our Society, that the energetic support it has given to the establishment of standard meridians of time in the United States, and the intelligent industry of its committee in distributing its printed publications on this subject, have contributed probably more than any other cause to the adoption of this reform over a large portion of the continent. Something remains to be accomplished in order to fully realize our views in this direction—a step so natural and simple in the path of rational progress that no serious argument is required to establish its value or propriety. If he who causes a blade of grass to grow where none grew before is a benefactor to his race, so is he a benefactor to his race who enables us to economize time and space by the use of one word instead of three in the notation of time.

Hence it is not strange that the members of our profession, with great unanimity, favor the numbering of the hours consecutively throughout the entire day, instead of dividing each day into halves of twelve hours each. We are fully aware that we contend with the prejudice of custom in our attempts in this direction. That great agent of modern

civilization, the railway, rendered the general adoption of Standard Time possible. Now, if that great agency in public education, the press, will adopt the proposed reform in its records of the daily hours, it is believed that "Ante" and "Post Meridian" time will soon be relegated to the past. The labors of our special Committee on Standard Time have been so fruitful in practical results thus far, that I submit for your consideration the desirability of its continuance, in the hope that its past and future appeals to the good sense of the public may result in the accomplishment of its full desires.

Our older members have observed with deep concern the rapid denudation of our forest lands, and the demands of increasing population bring questions of grave moment to the minds of every thoughtful engineer. Returning to the home of my boyhood with the recollections of only one-third of a century, I find now bare rocks and crags that in my youth were covered with a luxuriant growth of those green forest trees whence my native State derived its distinctive name. Visiting the great pine regions of the Northwest, we find the railway pushing its iron arms into the depths of the forest, seeking the lumber demanded in the settlement of those great treeless tracts of our continent west of the Mississippi and Missouri Rivers. Like conditions are found all over our continent wherever our work leads us. Though many may imagine that the supply of timber cannot be exhausted in the near future, we know the fact that stumpage has nearly doubled in value in the last decade; and I am assured by authority deemed reliable, that the aggregate amount of standing pine in the States of Wisconsin, Michigan and Minnesota does not much exceed 80 billion feet, while the present annual cut in these three States is 8 billion feet—the average cut per acre being about 5 000 feet.

Many of our railway companies in the West now find in the transportation of lumber their principal item of traffic. On some of the streams of Wisconsin the conversion of logs into lumber is so rapid and of such volume that navigation is impeded by bars of sawdust. It is estimated that the tonnage from one acre of pine land equals the tonnage of agricultural products subject to transportation that is likely to be raised on the same area in from ten to thirty years. In view of these facts, is it not pertinent to ask how the rapid diminution of this now cheap and chief resource of the engineer and architect for constructive purposes is to be compensated in the future? It is not in the power of man to

arrest the demand, and I assume that it would not be policy to do so if the power were granted. It is within our province of duty, however, to suggest processes by which decay may be arrested in degree, and to that end we have wisely appointed a special committee. I understand that this committee has collected valuable and voluminous data, which may prove of great value in the solution of this important problem. I understand that the committee will make a report of progress at this Convention.

I note with pleasure the growing interest shown by our profession in investigations as to the manufacture, use and properties of that peculiarly valuable and necessary material in all important works of construction—hydraulic cement. Unlike any other constructive substance, when properly made and used, it neither corrodes nor decays. Its special and peculiar value is further manifest in the fact that it has the property of increasing in strength with age, thus reversing the ordinary law of decay, in conformity with the adages, somewhat different but both true, that "When one hundred years are past and gone, good mortar turns to stone," and that "At one hundred years good mortar is but a child." The ancients conferred hydraulicity on their mortars through the use of puzzolana, and through its employment the constructions of the Romans of eighteen hundred years ago exhibit less of the destructive effects of time than the works in England of one thousand years later date, in which hydraulic mortar was not used. The first use of an artificial hydraulic mortar in England was by Smeaton, in building the Eddystone Light-house. This has resisted the wash of the waves for a hundred years, and is now replaced by a more modern structure solely because the abrading of the natural rocks on which it rests threatens its destruction. Quite rarely distributed over our own continent, and more rarely in perfect combination for our purposes, we find certain transitory rocks, generally lying between the distinct geological formations, and partaking somewhat in composition of the under and overlying formations, from which this wonderful product is manufactured. By the agency of fire, we undo the carbonizing process of nature in the formation of the rock, and bring the product to a condition convenient for our use, when, under proper manipulation, Nature resumes her right to impart strength and solidity to the mass. The manufacture of this material constitutes one of the largest and most important industries of the country at the present time, and its comparative value, with

the proper methods of testing value, and of attaining the largest results by accurate manipulation, are subjects which seem to demand rigid and systematic investigation by this Society and all intelligent engineers engaged in practical construction. Should it be determined by such investigation that the value of the American product, according to the opinion of many eminent authorities, is equivalent to the foreign product under certain conditions at less cost, or sufficient for all practical purposes in engineering, much would be gained to the country in an economic sense, and to this result our profession cannot be indifferent. Therefore, it is pertinent to ask whether in our works, and also in those of the architect, this remarkable substance has been understandingly and generously treated and applied as its merits and true economy demand. Is it generally understood that the subtraction of one measure of sand from our very common specification, that mortar of cement should be composed of one part of cement with two of sand, nearly doubles the strength? This I find to be true in the average of experimental tests made by myself upon sixteen different brands of our American product. Or is it generally understood to what extent hydraulic mortars should be applied as a source of health, durability and strength, in structures of either ordinary or extraordinary character? Many years ago, it will be remembered, the men, women and children of this country, in a spirit of patriotism, subscribed their mites toward the erection of a monument to be erected to perpetuate the memory of "the father of his country," the surveyor Washington. In 1848, sufficient collections having been made to warrant its commencement, its corner-stone was laid, an artist having been first employed to design the structure and a stone-mason to build it, and in the following eight years the shaft was carried to the height of 156 feet. In 1876, its completion was intrusted to a distinguished member of our Society. Evidently neither the artist nor the stone-mason had any idea of the strains that would be required in a structure of this magnitude, and you are all aware that a new base of cement, extending over 2½ times the area as originally constructed, has been inserted to secure the stability of the shaft. Although it is of record that the original commission having this work in charge did purchase a small quantity of hydraulic cement, an examination of the old mortar, excavated for the purpose of inserting the new base, showed a free use of quick-lime mortar and hardly any indications of cement. Visiting this work at the time, I took therefrom mortar that had lain there a third of a century, and found

it as soft as if a week old. Are not mistakes parallel to this being made to-day by both professed engineers and especially by architects? By reason of the great utility of the modern vertical railway, many buildings are being erected of heretofore unparalleled height, requiring thick and massive walls. In many instances, are not these walls laid solely in quick-lime mortar, in which the exposed part becomes carbonized, thereby shutting off the supply to carbonize and solidify the interior, whereas the induration of hydraulic mortar is an act of crystallization, and takes place alike throughout the mass? The one is also an absorbent of water, and under its influence remains soft, or crumbles under pressure, while the other is an expellant of moisture, except in so far as is necessary for crystallization. I will not take your time in an extended allusion to standard products from abroad, found especially useful when a maximum of strength within a brief time is deemed essential to the progress of the work. At least four-fifths of the cement used in this country now is of American production, sometimes variable in character because of want of uniformity in manufacture or manipulation, and therefore in works of special importance often requiring special examination, and special attention in manipulation and proportion of mixture. The experimental study of this product is one of exceeding fascination and importance, and I suggest to those of our members who are in charge of educational institutions the propriety of imposing upon pupils in any department relating to the duties of our profession the necessity of a complete practical knowledge of the manipulation of mortars and their properties, as a condition of graduation and of fitness to enter the profession. Perhaps in this way we may ultimately find one of our profession in this country who will make the matter his life's study, like Vicat, who devoted thirty years of his life to roaming over France in the pursuit of knowledge in this department. Your special Committee on Uniform Tests of Cement have formulated a partial report, which I trust will receive your earnest attention.

Intimately connected with the subject last presented, is that of concrete foundations for street pavements. Careful and somewhat extended experiments in this direction were instituted some years since under the responsible supervision of a distinguished member of our Society. Results in this country thus far are alleged to have equaled the highest anticipations, as to durability, cost and the public convenience, and especially in respect to those sanitary questions so largely involved in all enlight-

ened municipal administration. In fact, there are now few large cities in the United States in which this character of foundation may not be found exemplified, in association with surfaces of various material, including wood, stone and natural asphaltum. The latter material—natural asphaltum—has but recently become an important factor in American commerce, and fortunately exists in great abundance within convenient access from our seaports. The recent beneficent action of our State Department, through its consular agencies, reveals to us the interesting fact that "a variety of bituminous substances, from the pure hard asphaltum to the fluid naphtha and petroleum, are known to exist in immense quantities along the coast of the Gulf of Mexico," and that inexhaustible beds of nearly pure asphaltum are found near the port of Tampico, and at other points in Mexico, and also on the islands of Cuba and Trinidad, all at command of American capital and enterprise. [See "Commercial Relations of the United States"—Nos. 28, 31, 38—1883.] In view of the many purposes for which this cheap and abundant material is believed to be useful, and its rapid increase in public favor, I submit to you the question whether the circumstances do not justify a more definite consideration of its essential characteristics and practical value in connection with our profession.

The field of sanitary engineering is constantly enlarging. Questions involved in connection with the public health, the collection and disposition of household wastes, the prevention of the pollution of flowing water, and the better assurance of pure air, are receiving the serious attention of the public authorities and the careful and extended study of engineers.

The results of such attention and study are seen in improved household appliances, in the extension and improvement of existing systems of sewerage, and in movements toward the adoption of sewerage works in many places which heretofore have been without proper provision in this respect. The year past has been especially marked in large sewerage works by the completion of the new outlet connected with the improved system of Boston, a very extensive undertaking comprising several points of unusual interest, as well as by important works in other cities; among them the trunk sewer in Buffalo, which will be one of the interesting constructions to be examined during the period of this Convention. Gratifying progress has also been made in the introduction of sewers into a number of smaller towns, as in Keene, N. H.,

where a strictly separate system, with automatic flushing, has been brought into use.

The world's production of pig-iron has increased from 10 500 000 tons in 1869, to 20 500 000 tons in 1882. If the latter quantity were manufactured into a solid rod of iron one foot in diameter, it would be of sufficient length to girdle the world. In 1874, the total production of steel ingots in the United States was less than 200 000 net tons; in 1883, this reached 1 654 000 net tons, of which 1 300 000 tons were converted into rails. The price of steel rails has fallen from $90 per ton in 1874, to about $35 at the present time. I am advised of a late sale in England of nearly 50 000 tons of steel for bridge work, consisting of plates and angles, the former at $1\frac{73}{100}$ cents per pound, and the latter at $1\frac{63}{100}$ cents. This steel is guaranteed to have an ultimate strength of from 28 to 31 tons, an elastic limit of 18 tons, an elongation of 20 per cent. before fracture, and a contraction of area at fracture of from 43 to 45 per cent., carbon 15 to 20 hundreths of one per cent. In addition to the problems relating to the safe and economic use of iron yet unsolved, we must now give our earnest attention to those pertaining to the many grades of steel. We desire to know what precautions are necessary to be observed in its manipulation into the forms desired for construction purposes. That great problem of the experimental determination of the compressive strength of iron columns is not yet satisfactorily solved. We know but little of it in steel. Can we safely assume that the same ratio exists between the tensile and compressive strength of columns of steel that we have in iron? Tensile tests are made with comparative ease, while tests of columns are difficult and expensive, and the results vary per unit of measure according to length of the specimen tested and its form. We have a multiplicity of tensional tests and few of compression. The relation between the weight of the compressive members and those in tension in our bridges of 100 feet span and over, is nearly as 5 is to 4; hence it follows that our greatest uncertainty as to the strength of the structure is confined to its larger portion. You are all aware of the action taken by this Society, through its officers and its committee, in former years, in regard to the subject of tests of structural materials, and that its labors have been fruitful to some extent.

We cannot expect that a series of experimental tests, such as are demanded, can be secured except through governmental aid, and it seems fitting that they should be so made. You have been informed by cir-

cular that there has been included in the official book of estimates of the War Department a recommendation that Congress make certain appropriations in furtherance of experimental tests of materials. I have lately learned that the recommendation has been transferred in a modified form to the Sundry Civil Bill of Appropriations, and its ultimate fate I cannot conjecture. In a conference with the Chief of Ordnance, under whose direction tests of this character are made, subsequent to a previous conference with that officer by a committee of this Society, I found him keenly alive to our wants, willing and anxious to undertake a work that would bring such rich results for the public good Our duty toward the question of tests of structural materials will not end with this or the next Congress. Our Government has in its employ a servant which might be made to utter a volume of grand truths on this subject —I refer to the Watertown Testing Machine. To this end, the material aid of the Government is an essential condition. Should this aid be extended, we might then have reason to expect that facts far more eloquent than words from human tongue would fall from the lips of this marvellous invention of man—facts which will bring forth splendid results in the office of the engineer and architect, and finally enable our States to enter in their statutes, laws by which unworthy members of either profession may be convicted and punished in case of disastrous incompetency—a protection to the public and to the meritorious members of our profession now difficult to secure. May that cry of the little child that went out through the smoke and flame of that terrible night at Ashtabula, "Save me, mother!" ring in our ears and reverberate in our hearts until all of us are prompted to perform our full duty in forwarding by all proper effort the solution of all questions arising in our profession on which the security of human life depends.

When in every large city I see the evidences of human progress in the wires of those marvellous appliances for the convenience of man, the telegraph, the telephone, and the electric light, a metallic web across the face of the sky; when from my office window I look upon the site of the Newhall House conflagration, and see the wires still there upon which personal friends leaped to their death, I am forcibly impressed with the conviction that the engineer and the electrician must join hands and heads in their endeavor to eradicate the great evil involved in the present arrangement. In our attempts in this direction we must not lose sight of the benefits we have received from these ap-

pliances heretofore, their great necessity at the present time, the capital invested and the great interest at stake that may be injuriously affected by unwise or hasty legislative action. This is a subject now pressing upon your attention and demanding that serious and earnest consideration you have been disposed to accord to it in years past.

The continuous increase in the commerce tributary to the great valley of the lakes, and in the facilities of water and rail transportation eastward from a vast agricultural region yet in the infancy of its productive power, commend to your approbation and support every practicable plan for promoting efficiency and economy of transportation from the lakes to the seaboard. Therefore I feel assured that you will give thoughtful attention to the paper that I understand will be read at this Convention, treating of the practicability of the enlargement of the Erie Canal, to the end that lake vessels of the largest size may pass to tide water without break of bulk. Undoubtedly there can be found among our members those who from their knowledge of the physical obstacles to be encountered in such an undertaking are qualified to discuss this matter with that degree of intelligence its importance demands.

It was my hope to be able to present to this Convention some reliable information as to the success of the reservoir system about to be exemplified at the head waters of the Mississippi River. The object is to impound the surplus waters of spring and early summer for subsequent utilization in the interest of navigation during the periodic return of the season of low water. But I find that this work is not yet sufficiently advanced to permit me to give any experimental data of value at this time. The plan at present under consideration by the engineer in charge of that work refers not only to the head waters of the Mississippi, but also to those of the St. Croix, Chippewa and Wisconsin Rivers; and it is his calculation that from the entire resources there at his command, 14 600 cubic feet of water per second can be drawn for a period of ninety days, and practically a similar quantity be added to the discharge of the Mississippi below the mouth of the Wisconsin, during that period of time when navigation is ordinarily obstructed because of the deficiency in the depth of water. Should the experiment prove successful to the degree anticipated, it may then be of moment for us to determine how far any similar plan may be applied not only for the purposes of aiding navigation, but in ameliorating the condition of those many portions of our country periodically subject to destructive inundations,

often attended, as recently, by the loss of many lives and millions of dollars in property.

It is a just cause of mutual congratulation that this Annual Convention of our Society includes representatives from no less than twenty-five States and Territories of the American Union, in addition to distinguished members of our profession present from France and from at least three divisions of the British Empire—Canada, Nova Scotia and British Burma. This gratifying evidence of the continued prosperity of the organization is diminished in no degree by the fact that the purpose of this Convention has reference less to the pleasurable consumption of waste time than to the nobler purpose of comparing and utilizing the results of mutual experience.

It may be asked why we hold these Annual Conventions at places widely separated over the continent. Among other reasons to be given, is the sufficient fact that we are thus enabled to observe and study the works executed by our members, in the only perfect records and illustrations extant—in the channel cut by human agency at the mouth of the Mississippi River; in the steel arches that span the same mighty stream at St. Louis; in the first cantilever bridges of American construction at Kentucky River and at Minneapolis; in a like magnificent structure in the vicinity of our present place of meeting; and in hundreds of similar achievements, which first had existence as a vision woven in the brain of the civil engineer—each a volume of instruction in principles and practice, and a source of boundless inspiration to all those members of our profession endowed with the capacity of comprehending the visible monuments of human genius and skill.

During our present session, we expect to behold that most marvellous evidence of Nature's own majesty—Niagara. The artist and the poet have worshiped in picture and song all that is beautiful and picturesque in that mighty torrent, and to all of you who love Nature in concrete forms of beauty and grandeur, this phase of adoration is not denied. But as true disciples of our profession, we may see more than this in the mighty power of the sun, first exerted upon the great water-shed of the valley of the lakes, expending its excess of non-converted force in the abyss below the great fall—a vast and perpetual power passing forever to useless waste, while man stands dumb in the presence of the gigantic loss, his skill paralyzed and his genius defeated by the very immensity of the ruin. Surely, the mission of the engineer cannot be

deemed to have been fulfilled, or fairly appreciated, until the abundant voluntary forces of Nature have been conserved in a far greater degree than now—until wind and tide and all the forces of earth and air shall have become the willing servants of man.

It cannot be assumed that knowledge acquired from practical observation, as valuable as we know it to be, in any large degree supplies the place of either an established and perfected literature or mental education. In every pursuit, as a distinguished member of our Society once said, "when a man has learned how to learn, he can quickly learn anything." Much of the past and present, indeed, may be learned by such observation, and by actual labor in the field. But the ideal engineer is one who knows far more than can be taught him by sight or manual experience. By necessity he is concerned in a knowledge of all the sciences, and by an equal necessity he is dependent upon an intimate knowledge of all the abstruse principles of science. It is his duty both to create and apply knowledge. He must know the past, with all its noble examples and grand experiences; but he must also comprehend the future, and be constantly prepared for its successive revelations and infinite possibilities. Hence we need a literature far more complete than that we now possess; and still more a degree of preliminary education which will ensure a broader capacity, a more successful facility, a grander conception and comprehension of duty, and yet more splendid achievements in the line of our profession hereafter than we can now boast of. We have much reason to be grateful for the noble action of our national government some years ago, when it donated a portion of its magnificent domain to education in departments of knowledge vital to both the civil and mechanical engineer, and for the valuable work now being done in those departments of learning especially relating to our profession, under the guardianship and added patronage of the several States in their universities thus endowed. This is a source of hope and light in this direction to which we cannot be indifferent in action or expression; and there is reason to believe that it cannot long be said that our profession in America is without a literature, or that degree of culture upon which both the literature and the largest success of the profession mainly depend.

Our older members will soon have passed off the stage of active duty. Many of us commenced our professional career when but one or two of our educational institutions conferred the degree by which our calling

is designated. The most of our engineers now start with an advantage which we did not possess, in having received a thorough technical training. I would say to this class, soon to succeed us, that much more will be expected of you in the grand opportunities that await your coming than has been accomplished by us. With this advantage, coupled with thorough observation, mental activity, unflagging industry and moral rectitude, a sure way to professional preferment will be found in new and grander fields of duty than we have trod. Many times, under most humble circumstances, will be gained by experience that which will in after years enable you to overcome obstacles that threaten your professional pathway. Is it not possible that George Stevenson, with head bowed down to the ashes of the hearth in his early home, with eyes peering up into the grate watching the processes of combustion, was then conceiving the idea of the steam blast in the chimney, that which has made the locomotive the agent it is? Who knows but that then his brain became pregnant with the grand idea that bore fruit in after years, when he said that the sun was the primary physical source through which came the power to swiftly drive the railway train? And are not all possibilities with you, and especially with you in this age and in this land of boundless possibilities? Proud as we may be of the record of the past, who would not live to know the grander record of the future committed to your care? If from any cause you may desire to abandon our pursuit, may we not hope that some of you may leave it, as did Spencer or Tyndall, to enter upon investigations of life and Nature's evidences of law, training your minds to see clearly in that far-off field of human thought, where ours now see but dimly? As the Almighty grants you knowledge of His truth, our profession surely will ever stand ready to thank and remember those who reveal it, and to seize and utilize that truth for the best purposes of man.

AMERICAN SOCIETY OF CIVIL ENGINEERS.

INSTITUTED 1852.

TRANSACTIONS.

NOTE.—This Society is not responsible, as a body, for the facts and opinions advanced in any of its publications.

CCLXXXII.

(Vol. XIII.—June, 1884.)

ON THE COMPARATIVE LIABILITY TO, AND DANGER FROM CONFLAGRATIONS, IN LONDON AND IN AMERICAN CITIES.

By EDWARD B. DORSEY, M. Am. Soc. C. E.

READ MARCH 19TH, 1884.

During a visit in London, some time since, the writer devoted much attention to an investigation of the reasons for the fact, which is undoubtedly true, that large fires are much less frequent in that than in American cities. His attention had been particularly called to this subject by a number of published interviews with the Chief of the London Fire Brigade, when in the United States, in 1882. The inference which those interviews conveyed was that the absence of large fires in London was due to the superiority of the Fire Brigade, and the inference was also drawn, that the greater frequency of conflagrations in American cities, and particularly in New York, was due to the inferiority of their Fire Departments.

It is not at all intended in this paper to dwell upon, criticise or compare the different Fire Departments, but it is proper to say that the results of the writer's investigations, as given below, show that the circumstances existing in London and in New York are quite different, and also that the inference above alluded to, as to the inferiority of the Fire Department of the latter city, is unjust. The promptness, efficiency and bravery of American firemen are well known here and cannot be surpassed.

In order to make direct comparison, the writer has selected New York and London as typical cities. The following observations, however, will apply to most American and English cities, though, perhaps, with not quite the same force.

The London Fire Department receives much aid from the peculiarly damp climate. From the average of eleven years (1871 to 1881, inclusive) of the meteorological observations made at the Royal Observatory at Greenwich, the following approximate conclusions can be drawn: In London it rains, on the average, more than three days in the week; the sun shines only one-fourth of the time it is above the horizon; the atmosphere only lacks 18 per cent. of complete saturation, and it is cloudy seven-tenths of the time. Under these circumstances, wood must be nearly as wet, and as incombustible as it is possible to make it. It is, consequently, very difficult for sparks or contact with weak flame to ignite it. This is very different from the condition of wood in our long, hot, dry seasons. The humidity of the atmosphere in London is very uniform, varying but little in the different months.

The average temperature for the three winter months in London is 38.24 degrees Fahrenheit; in New York it is 31.56; New York being 6.68 degrees colder. This decrease of temperature must be the cause of many conflagrations, because, in order to make up for the deficiency in the natural temperature, there must be many more and larger domestic fires.

The following statistics from the records of the New York Fire Department, shows that lower temperature increases largely the number of fires:

In the three winter months of 1881, January, February and December, there were 522 fire alarms; average per month, 174. In the remaining nine months, 1 263; average per month, 140. In the same three months of 1882, there were 602 fire alarms; average per month, 201. In the

remaining nine months, 1 401; average per month, 155. Or, in round numbers, there were in 1881 one-fourth, and in 1882 one-third, more fire alarms in the cold winter months than in the nine warmer months.

The London Metropolitan Police District covers 690 square miles, extending 12 to 15 miles in every direction from Charing Cross, and contained, in 1881, 4 764 312 population; but what is generally known as London covers 122 square miles, containing, in 1881, 528 794 houses and 3 814 574 population; averaging 7.21 persons per house; 31 267 per square mile, and 49 per acre.

The population in New York is more dense than it is in London. South of Fortieth street, and between the Hudson and East Rivers, New York has an area of 3 905 acres, a fraction over 6 square miles, exclusive of piers, and contained, according to the census of 1880, a population of 813 076, viz.:

Wards.	Area in Acres.	Population. Census 1880.	Average per Acre.
1	141	17 939	127
2	95	1 608	17
3	93	3 582	39
4	80	20 996	262
5	141	15 845	112
6	79	20 196	256
7	195	50 066	257
8	169	35 879	213
9	281	54 596	194
10	102	47 554	466
11	223	68 778	309
13	112	37 797	338
14	107	30 171	282
15	231	31 882	138
16	331	52 188	158
17	298	104 837	357
18	442	66 611	153
20	405	86 015	212
21	380	66 536	175
Total	3 905	813 076	
Total average per acre			208

The census of 1880 reports the total number of dwellings in New York at 73 684; total population, 1 206 299; average per dwelling, 16.37.

For comparison, let us select an equal area from the most densely populated districts or parishes of London, as follows:

Name.	Acres.	Population.	
		Total.	Average per Ac
Clerkenwell (St. James)	380	64 778	170.
One half of Camberwell (St. Giles). (Total, 434 acres, 54 667 pop.)	217	27 333	126.
St. George. In the East	243	48 376	200.
St. George. Southwark	282	51 824	184.
St. Giles in the Fields. St. George. Bloomsbury	245	54 214	221.
Holborn	196	46 621	237.
St. James. Westminster	164	36 401	222.
City of London	434	55 932	129.
East London	153	44 406	290.
West London	136	28 790	211.
St. Luke. Old Street	220	54 155	246.
Shoreditch	646	109 257	168.
Strand	174	44 460	255.
Whitechapel	406	79 757	196.
Total	3 896	746 304	
Total average per acre			191.5

London averaged 191.5 persons per acre and per house 7.21. New York for the same area 208 per acre and 16.37 per dwelling.

This statement is hardly fair, as in London it only includes the most populous and poorest districts, corresponding to our entirely tenement districts, while in New York it includes the richest and most fashionable sections of the city as well as the poorest.

If the tenement districts should be taken alone, the population would be found much more dense, and New York proportionally much more densely populated; for example, take four of the most thickly populated of the London parishes, viz.:

Name.	Acres.	Population.	Av. per Acre.
East London	153	44 406	290.
Strand	174	44 460	255.
St. Luke's. Old Street	220	54 155	246.
St. Giles in the Fields, St. George. Bloomsbury	245	54 214	221.
Total	792	197 235	
Average population per acre			249.

Take four of the most densely populated New York wards of equal area, viz.:

Number.	Acres.	Population.	Av. per Acre.
10th	102	47 544	466.
11th	223	68 778	309.
13th	112	37 797	338.
17th	298	104 837	357.
Total	735	258 966	
Average population per acre			352.

This is forty per cent. greater than that of London; the districts are nearly the same size, each containing about one and one-fifth square miles

To accommodate this excess of population in our different style of buildings, and considering the much more free use of wood in their construction, it is safe to say that in New York there is more than double thequantity of wood used in buildings per acre, than in London. This

not only makes a fire more intense, but also more inaccessible to the firemen.

By selecting parts of the New York wards, the population would be still more dense.

The Fire Department, in 1882, counted the buildings in New York. The total, by their count, including detached sheds, was 106 885, of which there were built of wood or other inflammable materials :

	Below 59th St.	Total in City.
Buildings	9 714	28 798
Detached sheds	1 996	3 803
Total	11 710	32 601

The writer does not remember seeing in London one wooden building.

From personal inspection it is safe to say that sixty per cent. of all the London houses are less than fifteen feet wide, twenty-five feet deep in the clear, and twenty-two feet high from the pavement to the eaves, and contain less than 3 000 feet, board measure, of lumber. More than half of the remainder are less than 16 feet wide, 30 feet deep, and 40 feet high; very few being over 50 feet high. St. James' Palace does not exceed 40 feet, and the Bank of England not over 30 feet in height.

Many of the smaller houses have a back building about half the width, depth and height of the main building. All houses have a brick division-wall terminating in a high fire-wall between each house. All have fire-proof roofs, generally slate or tile.

In most of the larger houses, and also in a great many of the smaller ones, the partition or interior division walls are of brick, and in most of the larger houses, both for dwellings and business purposes, the staircases are of stone, there being in all cases proportionately much less wood and more brick and stone than in New York buildings.

The London houses have generally fewer and smaller windows than in New York; more than sixty per cent. of the houses have on the first floor only one small window and door front and rear, and on the second floor two small windows front and rear, and more than half of the remaining houses have, in addition to the preceding, two small windows on the third floor front and rear.

The walls being short, low and generally well tied together, will not fall after the little woodwork within them has been burned, and the flames resulting from the burning of this woodwork will be confined within the walls, except the little that can escape through the few small windows and doors. These will, in most cases, be too feeble to ignite opposite or even adjoining houses, especially as the woodwork is always very damp, and often wet.

Owing to the lowness and stability of the walls, the firemen can approach close to them without danger.

There are no wooden roofs or outbuildings, and but little wood in the yards in fences or rubbish.

The ash barrel or box, so frequently the cause of fires in New York, is unknown in London, as each house is required by law to have a vault built of masonry for ashes.

The London firemen derive great aid in checking fires from the peculiar plan of London, as will be seen by reference to a map.

The river Thames divides the city into two parts, from northeast to southwest. The river Thames, St. James' Park, Green Park, Hyde Park-Kensington Gardens, and Holland Park, divide the city almost entirely from east to west. St. James' Park, Green Park, Hyde Park, Regent's Park, Primrose Hill, and Albert Park, almost divide the city north to south from the Thames.

The numerous smaller parks, squares, circuses, crescents, cemeteries, church-yards, private grounds, etc., offer equally good, though smaller barriers to the spreading of fires.

The numerous railroads running into London (except the Metropolitan and District) are effectual barriers to the spreading of fires, as when built above ground, they are either embankment, solid walls, or brick viaducts, being, on the top, from sixty to one hundred and fifty feet wide, and generally higher than the tops of the houses, and when built below the street level, are open cuts, eighty to one hundred and fifty feet wide. The numerous railroad stations are also great helps, as they are large and fire-proof.

In addition to all these advantages the city is intersected in every direction by many streets, so wide that flames could not ignite the buildings opposite, even if the buildings should be the highest in London.

It is evident that the London firemen are greatly aided by extraneous advantages, which briefly summarized are:

1st. The small size of most of the houses, which confines the fire to a very limited space between brick walls.

2d. The low, strong and well-braced walls, which enable the firemen to approach them without danger.

3d. The high and effectual fire walls between adjoining houses.

4th. The great benefit derived from the houses being low and small, enabling the firemen to throw water easily all over them, and with a very short ladder to reach the roof. And also avoiding the great draught drawing the fire up the stairways and wells of high buildings.

5th. The use of more brick and less wood in buildings.

6th. Absence of all frame buildings.

7th. Absence of all wooden additions, outbuildings or fences.

8th. Fire-proof roofing.

9th. Absence of ash barrels or boxes.

10th. The moist or wet climate which prevents sparks or weak flame from igniting wood.

11th. The parks and Thames River, which divide the city into distinct fire divisions.

12th. The numerous parks, squares, private grounds, wide streets, railroads, etc., all of which are effectual barriers to the extension of fire.

13th. The mildness of the winter climate.

14th. The great care of the authorities in prohibiting the manufacture or storage of combustible materials, etc., in the populous portion of the city.

15th. The very few telegraph wires in the streets above ground to interfere with the work of the firemen.

Contrast the preceding with New York, with its numerous wooden buildings, wooden or asphalt roofs, buildings from four to ten stories high, with long unbraced walls, weakened by many large windows, containing more than ten times the lumber the average London house does, and that very inflammable, owing to our dry and hot climate; the five and six-story tenement houses, with two or three families on each floor, each with their private ash barrel or box, kept handy in their rooms, all striving to keep warm during our severe winters; the narrow streets and high buildings, with nothing to obstruct the spreading of a fire

except a few small parks; the perfect freedom with which the city authorities allow in the most populous portions of the city large stables, lumber yards, carpenter shops, and the manufacture and storage of inflammable materials; the absence of high or effectual fire-walls between buildings.

The advantages of London thus suggested, except the climate, are common to most European cities, and have saved them from destruction by fire, even where the Fire Department has been of little efficiency.